NRG Systems IceFree RT240

& NRG Systems RT20

Ultrasonic Wind Sensor

Part number 5747 and 5749 User Manual

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1 Using this Manual

Read this manual completely before installing and operating the sensor. Follow all instructions and recommendations closely.

1.1 Symbols

This document and the sensor may use the following symbols:

Earth (Ground)

Chassis Ground

AC Voltage

AC or DC Voltage

DC Voltage

Hot Surface

Warning

This typeface within the body of the manual is used for general descriptions and instructions to the user.

This typeface is used to warn users of a potential danger, either to them or to the sensor.

1.2 Abbreviations

Abbreviations are used throughout this manual and are defined as follows:

act Most Recent Measurement

min Minimum Value

max Maximum Value

avg Average Value

vct Vectorial Average Value

2 Table of Contents

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3 Theory of Operation

3.1 Wind Speed and Direction

The NRG ultrasonic wind sensor is constructed with four ultrasonic transceivers which can both transmit and receive ultrasonic sound waves. The transceivers operate in pairs to send sound pulses from one to the other, bouncing the signal off the "ceiling" of the sensor and measuring the time of flight over the fixed distance. By performing four of these measurements, in four mutually perpendicular directions, the wind speed and wind direction can be calculated.

3.2 Virtual Temperature, Barometric Pressure

While the NRG Ultrasonic Wind Sensor cannot directly measure the temperature of the air, because it is heated and therefore changes the temperature sensor, it can infer a value called the "Virtual Temperature" by using the time of flight measurements already measured and by measuring the barometric pressure. The virtual temperature is the temperature of the air as if all moisture been removed from it without changing its pressure and density.

The barometric pressure is measured by an integrated barometric pressure sensor.

3.3 Measurement Definitions

3.3.1 Most Recent Measurement (act)

In accordance with the specified sampling update rate (1 to 10 seconds), the value of the last measurement is transmitted when a new measurement value is requested. Each measurement is stored in a circular buffer for the subsequent calculation of minimum, maximum and average values.

3.3.2 Minimum, Maximum, and Average Values (min, max, and avg)

The most recent measurements (act) are all placed in a circular buffer (first in, first out) that includes the number of needed for the averaging sample count configured at the factory, per customer specification. This buffer is then used to calculate the minimum, maximum, and average.

Note: The averaging sample count for wind-related measurements can be set from 1 to 60 *measurements.* Barometric pressure has its own buffer and can average from 1 to 10 *minutes*.

Note: In the case of wind direction, the minimum / maximum value indicates the direction at which the minimum / maximum wind speed was measured.

3.3.3 Vectorial Average Value (vct)

The vector averaging method breaks down the individual velocity vectors (speed and direction pairs) into orthogonal component values. It then averages those components and recombines the result to report a "vector average" speed and "vector average" direction. This method is far more accurate than simply averaging the speeds and directions individually.

4 Introduction

The NRG IceFree RT240 and RT20 Ultrasonic Wind Sensors are wind direction and wind speed sensors. Both sensors are also capable of calculating barometric pressure, virtual temperature, and the quality of the signal.

The RT240 is all aluminum, fully heated sensor rated for offshore use. The RT20 is a polycarbonate sensor with a 20W heater to minimize freezing. The heaters on both sensors can be thermostatically controlled.

The equipment is connected with an 8 pole screw connector (see specifications).

The measured values can be requested over a variety of interfaces:

- RS485 interface in half or full duplex
    - UMB binary protocol
    - UMB ASCII protocol
    - NMEA protocol (0183)
    - SDI-12 protocol
    - Modbus-RTU and Modbus-ASCII protocols
- Analog data output of 2 adjustable channels

RS485 interface, 2 or 4 wire, half or full duplex

Data bits:	8	(SDI-12 mode: 7)
Stop bit:	1	
Parity:	No	(SDI-12 mode: even)
Tri-state:	2 bits after stop bit edge	
Adjustable baud rates:	1200, 2400, 4800, 9600, 14400, 19200, 28800, 57600	

(when entering SDI-12 mode the circuit is switched to conform to the standard's requirements)

	Ranges
Analog interface circuits (A, B):	A: 0 or 4 - 20mA / 0 or 2 – 10V / 2 – 2000Hz
	B: 0 or 4 - 20mA / 0 or 2 – 10V

Resolution:	16 bits
Channels:	Adjustable
Update rate:	1-10 seconds
Averaging Sample Count	1 – 60 measurements

The RT240 and RT20 are configured at NRG Systems per customer specification.

5 Measurement Outputs

The analog measurement outputs are configured at the factory based on customer specification. However, when using digital communications, all of the sensor's measurement capabilities are available. If you are using an analog output (such as 4-20mA), 2 channels are available. These 2 channels are typically used for wind speed and wind direction outputs, but any of the available measurements can be routed to the analog outputs if needed.

The wind-related measurements (Wind Speed, Wind Direction, and Virtual Temperature), as well as the Heating Temperature (Sensor Body Temperature), all share an update rate (1 – 10 seconds) and averaging sample count (1 – 60 samples). They cannot be set independently.

The wind-related measurements also share the threshold setting which can be set as low as 0.1m/s (0.22mph). In wind below the threshold speed setting, the sensor will report zero for speed and direction.

The Barometric Pressure measurement can be independently set to average over 1 to 10minutes.

When using digital communications, the units for each measurement can be selected as shown below. For analog outputs, the signals are scaled independently of units.

5.1 Wind Speed

Units m/s; km/h; mph; kts

	Measuring Range		
Measurement Variable	**min**	**Max**	**Unit**
Wind Speed	0	75.0	m/s
Wind Speed	0	270.0	km/h
Wind Speed	0	167.8	Mph
Wind Speed	0	145.8	Kts

5.2 Wind Direction

Unit °

	Measuring Range		
Measurement Variable	**min**	**Max**	**Unit**
Wind Direction	0	359.9	°

The minimum / maximum wind direction indicates the direction at which the minimum / maximum wind speed was measured.

5.3 Virtual Air Temperature

Units °C; °F

	Measuring Range		
Measurement Variable	**Min**	**max**	**Unit**
Virtual air temperature	-50.0	70.0	°C
Virtual air temperature	-58.0	158.0	°F

5.4 Heating Temperature

Units °C; °F

	Measuring Range		
Measurement Variable	**Min**	**max**	**unit**
Heating temperature top	-50.0	150.0	°C
Heating temperature bottom	-50.0	150.0	°C
Heating temperature top	-58.0	302.0	°F
Heating temperature bottom	-58.0	302.0	°F

Note: On the RT20, only the bottom temperature is available.

5.5 Barometric Pressure

Sampling rate 10 seconds

Generation of average value 1 to 10 minutes

Units hPa

	Measuring Range		
Measurement Variable	**Min**	**max**	**unit**
Absolute barometric pressure	300.0	1200.0	hPa
Relative barometric pressure	300.0	1200.0	hPa

5.6 Wind Measurement Quality

Units %

	Measuring Range		
Measurement Variable	**min**	**Max**	**Unit**
Wind measurement quality	0	100	%

The Wind Measurement Quality value allows the user to assess how well the measurement system is functioning. Under normal circumstances, the value is 90 - 100%; however, values as low as 50% do not represent a general problem. If the value falls to zero, the measurement system is not working properly (there may be debris on the sensor, for example).

When a value of 0% is reached, the error value is transmitted for wind speed and wind direction [55hex (85decimal) for digital channels, and a user defined error level for analog signals] meaning that the sensor is unable to execute valid measurement due to incompatible ambient conditions.

6 Heater operation

The heating system on the RT240 consists of two separate heaters to keep the sensor free of ice and snow. The heater elements are located in the upper and lower housings. The RT20 has one heating element in the lower half for prolonged operation during winter conditions.

As part of the configuration process, the heater control mode and heater capacity is set at the factory based on customer specification.

6.1 Heater Modes

1. Heater off

2. Automatic Heater Control - The heater switches on when the housing temperature falls below a set point (adjustable between 2 ° C and 20 ° C.) This set point is part of the factory configuration based on customer specification. Default is 5 ° C.
3. Heater is disabled when the control line is at the high level - otherwise it operates in the automatic mode.
4. Heater is disabled when the control line is at the low level – otherwise it operates in the automatic mode.

6.2 Heater Capacity

The heater capacity on the RT240 must be selected. Full capacity is the default selection for the RT240. The heater capacity on the RT20 is always 20W.

1. Full capacity (240W)
2. Alternating heating (maximum 150W heating): the top cover plate heater alternates with the base plate heater (approximately 100W and 150W respectively).

   Note: When alternating, if the set point temperature (plus 5°C) is not reached within 4 minutes, power is switched to the other heater.

   Note: Many of the heater controls can also be set using certain digital communications protocols. See the appropriate appendices for details.

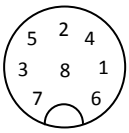
7 Connections

There is an 8 pole screw connector on the underside of the RT240 and the RT20. This connects the supply voltage and interfaces via a connection cable.

When connecting the sensor and heater supply voltages, the correct polarity must be strictly observed. Reversed polarity will cause damage of the instrument. In addition, do not short the outputs to ground or each other.

Full Duplex Pin Assignment:

Pin #	Function	Cable Color
1	Serial interface RXD -	pink
2	Serial interface TXD -	yellow
3	Control connection	Red
4	Serial interface RXD +	Grey
5	Serial interface TXD +	Green
6	Analog ground	Blue
7	Supply voltage -	White
8	Supply voltage +	Brown



View on cable socket solder connection

The connection of the cable shield is different for the RT240 and RT20. Please see the **Cable Shielding** section below.

Pin assignment half duplex/analog interface:

Pin #	Function	Cable Color
1	Analog interface A	Pink
2	Serial interface RXD/TXD -	Yellow
3	Not Used	Red
4	Analog interface B	Grey
5	Serial interface RXD/TXD +	Green
6	Analog ground	Blue
7	Supply voltage -	White
8	Supply voltage +	Brown

The connection of the cable shield is different for the RT240 and RT20. Please see the **Cable Shielding** section below.

Pin assignment SDI-12 interface:

Pin #	Function	Cable Color
1	Not Used	pink
2	SDI-12 Data (B)	yellow
3	SDI-12 Activation	red
4	Not Used	grey
5	SDI-12 Ground (A)	green
6	SDI-12 Data	blue
7	Supply voltage -	white
8	Supply voltage +	brown

The connection of the cable shield is different for the RT240 and RT20. Please see the **Cable Shielding** section below.

If the equipment is not connected correctly

- It may not function
- It may be permanently damaged
- The possibility of an electrical shock may exist under certain circumstances

7.1 Supply Voltage

The supply voltage for both the RT240 and RT20 is 24V DC ± 10%. The power supply used must be approved for operation with equipment of protection class III (SELV).

7.2 Cable Shielding - Important

The user must correctly connect the shield of the signal cabling in accordance with the overall design of the lightning protection and grounding system for each turbine design. The RT240 and RT20 are significantly different from each other in this respect as described below.

7.2.1 RT240

For the RT240, the cable shield is connected to the sensor (the connector body is connected to the shield and the sensor body). Assuming that the mounting post is metal and appropriately grounded, this provides shielding against capacitively (electrostatically) coupled interference with the sensor signal.

If the cable shield can also be connected to ground at the controller end of the cable, the shield can also provide protection against inductive (magnetically) coupled noise sources, such as generator noise and lightning electromagnetic pulses. However, the shield should be connected at the controller end ONLY if the turbine grounding system provides sufficient bonding and grounding to prevent ground loop currents in the shield wire.

If the controller end of the shield is not to be connected, make sure to cut and insulate the shield end to prevent accidental contact to grounded structures.

7.2.2 RT20

Because of the plastic body on the RT20, the cable shield ***must*** be connected to ground at the controller end. This provides shielding against capacitively (electrostatically) coupled interference with the sensor signal. There is no shield-to-ground connection at the sensor end of the cable.

7.3 Additional Lightning Protection Recommendations:

The long-term reliability and the Electromagnetic Compatibility (EMC) performance of the sensor are dependent on proper installation and connections. These recommendations could apply to any control electronics or sensors, but are particularly critical for wind sensors because they are exposed on the top of the nacelle.

1. IEC 61400-24 classifies several Lightning Protection Zones (LPZ). LPZ 0_A is exposed on the surface of the turbine and is subject to direct lightning attachment. The turbine must provide air terminals such as lightning rods to protect the sensors from direct lightning attachment. This creates an area in LPZ 0_B to mount the sensors.
2. Careful routing of the lightning down-conductor and coordination of the grounding and bonding of the down-conductor(s) to the turbine's LPS is required to minimize the energy coupled into other systems such as the sensors. Provide maximum possible spacing between lightning down-conductors and any control cabling or raceway. Do not route any other cabling or raceway alongside the lightning down-conductors. These measures will minimize the coupling of lightning electromagnetic pulse (LEMP) energy into other turbine systems.
3. The mounting mast must be metal. Take particular care to bond the sensor mounting mast to the turbine's LPS in coordination with the placement and bonding of the lightning air terminals and bonding of the turbine frame and nacelle.
4. Use shielded or "screened" cable with high shield coverage for sensor cabling
5. Run the sensor cabling in metallic raceway or conduit. Bond the raceway or conduit to the LPS at both ends. This provides protection for the sensor and cabling against EMI and LEMP.

The purpose of recommendations 1 through 5 is to provide shielding of the internal sensor electronics, heater, and cabling so that they are protected to LPZ 1, per IEC 61400-24.

Recommendations 6 and 7 relate to ground loops and over-voltage protection.

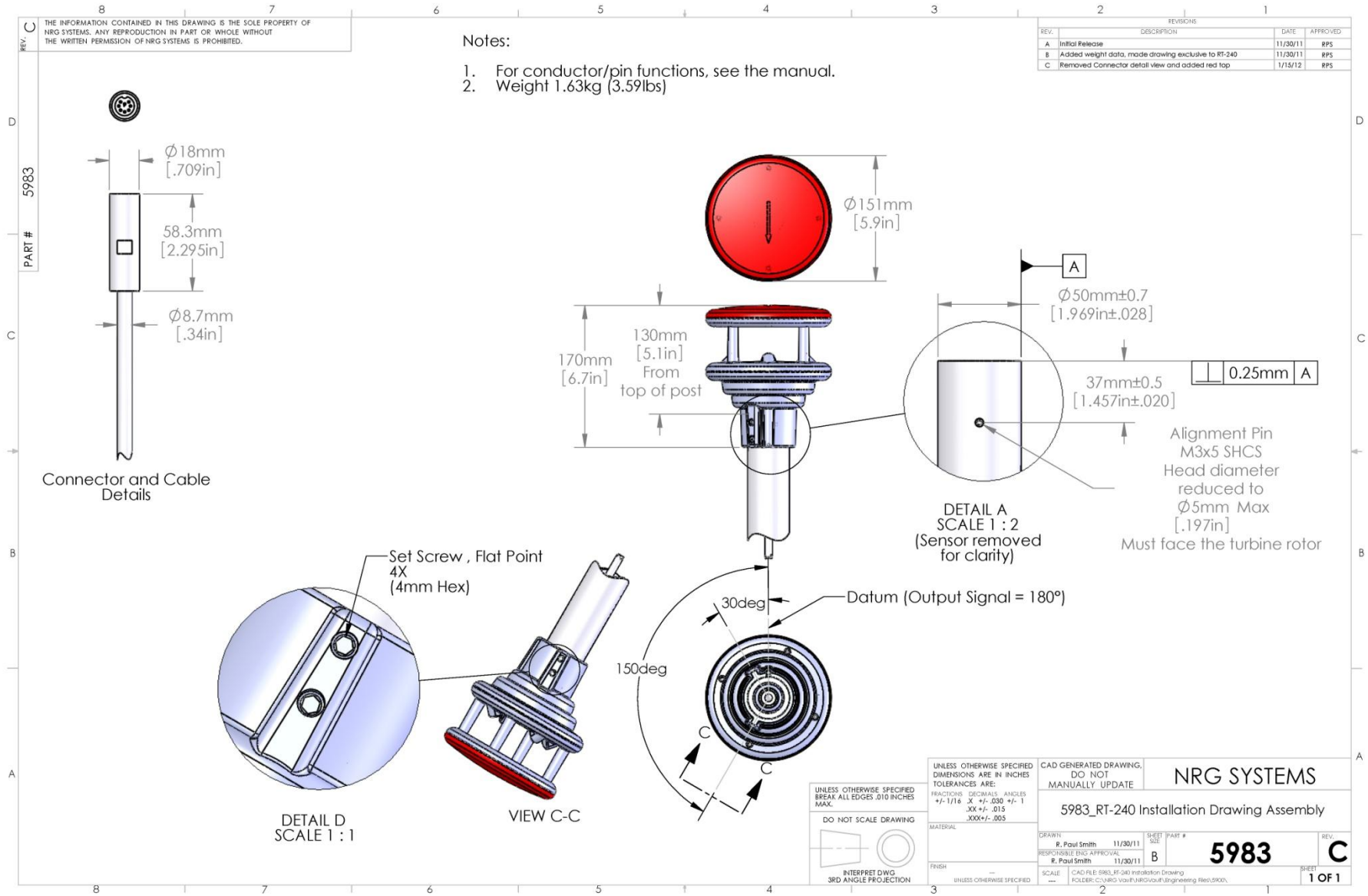
6. Provide sufficient bonding to prevent ground loop currents in the shields and raceways. Whenever possible, it is better to resolve the underlying grounding problems, rather than leaving the shield unconnected to prevent ground loop current flow.

7. Since the sensor's electronics and cabling are in LPZ 1, isolation and or over-voltage protection should be provided at the interface between the sensor cabling and turbine control system to provide LPZ 2 or better protection for the controller.

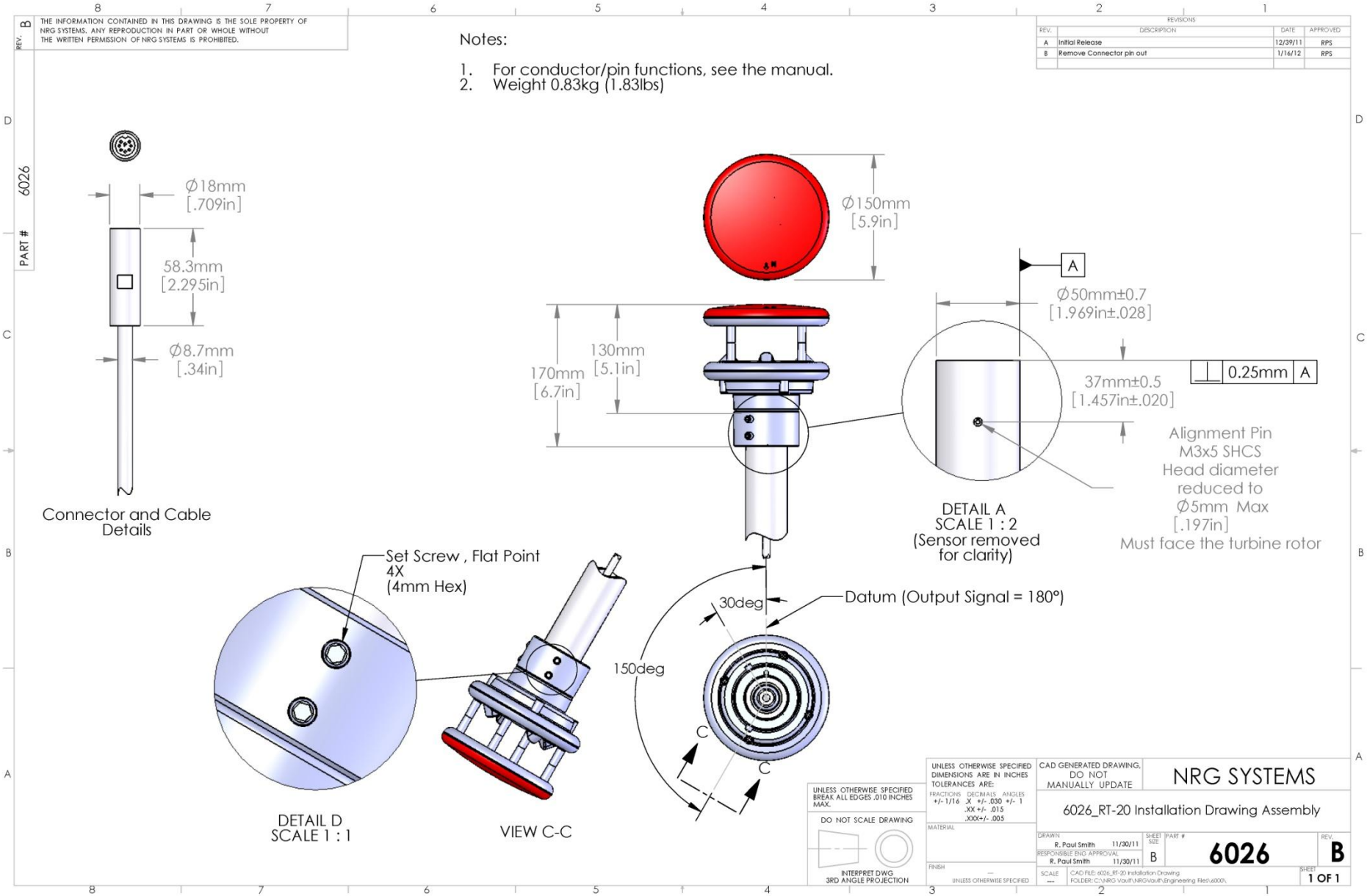
8 Maintenance and Troubleshooting

The sensor is essentially maintenance free. However, it is recommended to visually inspect the surface of the transceivers for soiling annually or if a problem is suspected.

9 Installation – RT240


THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF NRG SYSTEMS. ANY REPRODUCTION IN PART OR WHOLE WITHOUT THE WRITTEN PERMISSION OF NRG SYSTEMS IS PROHIBITED.
REV. C
PART # 5983
Notes:
1. For conductor/pin functions, see the manual.
2. Weight 1.63kg (3.59lbs)
REVISIONS
REV. DESCRIPTION DATE APPROVED
A Initial Release 11/30/11 RPS
B Added weight data, made drawing exclusive to RT-240 11/30/11 RPS
C Removed Connector detail view and added red top 1/15/12 RPS
Ø18mm [.709in]
58.3mm [2.295in]
Ø8.7mm [.34in]
Connector and Cable Details
Ø151mm [5.9in]
170mm [6.7in]
130mm [5.1in] From top of post
A
Ø50mm±0.7 [1.969in±.028]
37mm±0.5 [1.457in±.020]
0.25mm A
Alignment Pin M3x5 SHCS Head diameter reduced to Ø5mm Max [.197in] Must face the turbine rotor
DETAIL A SCALE 1 : 2 (Sensor removed for clarity)
Set Screw , Flat Point 4X (4mm Hex)
30deg
Datum (Output Signal = 180°)
150deg
C
C
DETAIL D SCALE 1 : 1
VIEW C-C
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS +/- 1/16 DECIMALS .X +/- .030 .XX +/- .015 .XXX +/- .005 ANGLES +/- 1
UNLESS OTHERWISE SPECIFIED BREAK ALL EDGES .010 INCHES MAX.
DO NOT SCALE DRAWING
INTERPRET DWG 3RD ANGLE PROJECTION
MATERIAL
FINISH
UNLESS OTHERWISE SPECIFIED
CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE
NRG SYSTEMS
5983_RT-240 Installation Drawing Assembly
DRAWN R. Paul Smith 11/30/11
RESPONSIBLE ENG APPROVAL R. Paul Smith 11/30/11
SHEET SIZE B
PART # 5983
REV. C
SCALE ---
CAD FILE: 5983_RT-240 Installation Drawing
FOLDER: C:\NRG Vault\NRGVault\Engineering Files\5900\
SHEET 1 OF 1

10 Installation – RT20


THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF NRG SYSTEMS. ANY REPRODUCTION IN PART OR WHOLE WITHOUT THE WRITTEN PERMISSION OF NRG SYSTEMS IS PROHIBITED.
REVISIONS
REV. DESCRIPTION DATE APPROVED
A Initial Release 12/39/11 RPS
B Remove Connector pin out 1/16/12 RPS
Notes:
1. For conductor/pin functions, see the manual.
2. Weight 0.83kg (1.83lbs)
PART # 6026
Ø18mm [.709in]
58.3mm [2.295in]
Ø8.7mm [.34in]
Connector and Cable Details
Ø150mm [5.9in]
170mm [6.7in]
130mm [5.1in]
A
Ø50mm±0.7 [1.969in±.028]
37mm±0.5 [1.457in±.020]
0.25mm A
Alignment Pin M3x5 SHCS Head diameter reduced to Ø5mm Max [.197in] Must face the turbine rotor
DETAIL A SCALE 1 : 2 (Sensor removed for clarity)
Set Screw , Flat Point 4X (4mm Hex)
DETAIL D SCALE 1 : 1
VIEW C-C
30deg
Datum (Output Signal = 180°)
150deg
C
C
UNLESS OTHERWISE SPECIFIED BREAK ALL EDGES .010 INCHES MAX.
DO NOT SCALE DRAWING
INTERPRET DWG 3RD ANGLE PROJECTION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
+/- 1/16 .X +/- .030 +/- 1
.XX +/- .015
.XXX+/- .005
MATERIAL
FINISH
UNLESS OTHERWISE SPECIFIED
CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE
NRG SYSTEMS
6026_RT-20 Installation Drawing Assembly
DRAWN P. Paul Smith 11/30/11
RESPONSIBLE ENG APPROVAL R. Paul Smith 11/30/11
SHEET SIZE B
PART # 6026
REV. B
SCALE ---
CAD FILE: 6026_RT-20 Installation Drawing
FOLDER: C:\NRG Vault\NRGVault\Engineering Files\6000\
SHEET 1 OF 1

11 Analog Interface Circuits

Two analog interface circuits are provided for analog data transmission – Interface A and Interface B.

Interface A can be configured for 0 to 20mA current output (typically 4 to 20mA), 0 to 10V voltage output as well as for frequency output in the range from 2 to 2000Hz (with adjustable voltage level up to 10V).

Interface B can be configured the same as with Interface A except that no frequency option is available.

The scaling of the outputs is determined by the configuration of the sensor. Please work with NRG to properly define the correct scaling for your application.

Note: If the RT240 or RT20 is configured for any full duplex serial communications protocols, it is not possible to use the analog outputs.

The maximum load impedance on the current outputs is 500 Ω. The minimum load impedance on the voltage outputs is 500Ω.

The default settings for the RT240 and RT20 are below:

1. Update Rate (1 to 10 seconds) – default - 1 second
2. Averaging Sample Count (1 to 60) – default 1
3. Threshold – default 0.1m/s
4. Heater Mode - default automatic
5. Heater Temperature Set point – default 5 degrees C
6. Heater Power Level – default 240W for the RT240 and 20W for the RT20

Analog Interface settings:

1. Interface A:
   Wind speed – default 4mA = 0 m/s and 20mA = 75m/S
   Error output – default 2mA
2. Interface B:
   Wind direction – default 4mA = 0° and 20mA = 359.9°
   Error output – default 2mA

12 Digital (RS485) Interface

The equipment has an electrically isolated RS485 interface for measurement polling and sensor control. The RS485 interface can operate in half or full duplex mode (2 or 4 wire connection).

The following operating restrictions exist depending on the half or full duplex operation setting:

Full duplex	Half duplex
Autonomous telegram transmission is possible	No autonomous telegram transmission possible
Transmission of values via current, voltage, or frequency output is not possible	Transmission of values via current, voltage, or frequency output is possible
Heating control via control pin is possible	Heating control via control pin is possible
Triggering of NMEA telegram transmission over Control-PIN is possible	Triggering of NMEA telegram transmission over Control-PIN is not possible
SDI-12 Mode overrides the duplex setting	SDI-12 Mode overrides the duplex setting

Please see Appendices A through C for detailed descriptions of each protocol.

12.1 Fault Description Table – Digital only

Fault Description	Cause - Remedy
The device does not allow polling or does not respond	- Check supply voltage - Check interface connection - Incorrect device ID → check ID; devices are delivered with ID 1.
Device transmits error value 28h (40d)	Device is in initialization phase after start-up → device delivers measurement values after about 10 seconds
Device transmits error value 50h (80d)	Device is being operated above the specified measuring range (e.g. above 75m/s)
Device transmits error value 51h (81d)	Device is being operated below the specified measuring range
Device transmits error value 55h (85d) for wind speed or direction	Device unable to carry out valid measurement due to unfavorable ambient conditions.

measurement	There may be several causes for this: - Device is being operated above the specified measuring range - Very strong horizontal rain or snowfall - There are foreign objects in the measuring section of the sensor - Ultrasonic sensors are heavily soiled → clean sensors - Ultrasonic sensors are iced up → verify heating function and/or the connection/voltage of power supply - One or more of the ultrasonic sensors is faulty → return the sensor to NRG for repair
The quality of the wind measurement is not always 100%	The device should always transmit 90 – 100% in normal operation. Values as low as 50% do not represent a general problem. When error value 55h (85d) is transmitted, this value is 0%. The device may be faulty if after cleaning it permanently transmits values below 50%.
Device transmits an error value not listed here	There may be several reasons for this behavior → contact NRG Technical Support.
Minimum value of wind direction is greater than maximum value	This is not an error. The maximum and minimum wind direction values indicate the direction at which the minimum/maximum wind *speed* was measured.

13 Appendix A: Digital Communication – MODBUS

The MODBUS protocol is available to enable the integration of RT240 and RT20 wind sensors into PLC and similar environments.

Measurement values are mapped to MODBUS input registers. The implementation of the MODBUS protocol includes all measurements of which the sensor is capable, including the translation into different unit systems (SI units, Imperial …).

In the interest of safe and simple commissioning, the RT240 and RT20 do not use register pairs for floating point or 32 bit integers, as the use of register pairs is not described in the MODBUS standard documents. All measurement values are scaled to fit into 16 bit integer registers.

13.1.1 MODBUS Communication Parameters

RT240 and RT20 can be configured with the following options

MODBUS operating mode: MODBUS – RTU or MODBUS - ASCII

Baud Rate: 19200 (9600, 4800 or less)

Data Bits: 8

Parity: E or N

Stop Bits: 1

Note: RT240 MODBUS communication has been tested with 1 sec poll rate. *Proper function of the device will not be guaranteed for higher poll rates.*

13.1.2 Addressing

Valid MODBUS addresses are 1 to 247.

13.1.3 MODBUS Functions

The functions of Conformance Class 0 and 1 have been implemented, as far as they are applicable for RT240, i.e. all functions working on register level.

	Conformance Class 0	
0x03	Read Holding Registers	Selected configuration settings
0x16	Write Multiple Registers	Selected configuration settings
	Conformance Class 1	
0x04	Read Input Registers	Measurement values and status information
0x06	Write Single Register	Selected configuration settings
0x07	Read Exception Status	Currently not used (returns 0)
	Diagnostics	
0x11	Report Slave ID	(replies to broadcast address as well)

13.1.3.1 Holding Registers

The Holding Registers are used to make a limited set of adjustable sensor parameters available using MODBUS communication (these registers have been preset at the factory). Similar to the measurements, values are mapped to 16 bit integer values, if necessary by appropriate scaling.

Use Function 0x03 to Read the Holding Registers, and Functions 0x06 Write and 0x16 Write Multiple to change the values in the Holding Registers.

The values are checked for plausibility. Improper values will not be accepted and cause a MODBUS exception.

Reg. Addr.	Function	Values	Scale
0	Local Altitude	Altitude in m, for calculation of relative barometric pressure Value range -100 … 5000	1.0
1	Heating operating mode	High-Byte: Heating Operating Mode Low-Byte: Heating Power Mode See below for details.	
2	Station Reset	Writing the value 0x3247 (12871d) into register 2 will trigger a device reset. (reading always returns 0)	

Register 1 Details:

The RT240 has 2 heating elements to keep the sensor free of snow and ice. One element is in the cover and the other is built into the casting around the ultrasonic sensors.

Control Modes:

The sensor's heating can be operated in 5 different modes:

- 0x00: Heating always off
- 0x01: Automatic heating control:
  - The heating switches on when the housing temperature falls below the setpoint and switches off when the housing temperature exceeds the setpoint by 5°C.
- 0x02: The setpoint temperature is set to +40°C; in this condition the heating switches on at room temperature (for test purposes only).
- 0x03: Heating is off when the control line (Pin 3, Red wire) is at the "high" level; otherwise it is automatically controlled.

- 0x04: Heating is off when the control line (Pin 3, Red wire) is at the “low” level; otherwise it is automatically controlled.

Heating Power:

The heating power can be set in accordance with the following modes:

- 0x00: Full heating capacity: (approximately 240W)
- 0x01: Alternating heating: The top cover plate heater alternates with the base plate heater (approximately 100W and 150W respectively).

  Note: When alternating, if the setpoint temperature (plus 5°C) is not reached within 4 minutes, power is switched to the other heater.

13.1.3.2 Input Registers

Use Function 0x04 to read the Input Registers which contain the measurement values of the sensor and the related status information.

The measurement values are mapped to the 16bit registers using scaling factors:

(0 … 65530 for unsigned values [Note this is not 6553***5***]

-32762 … 32762 for signed values [Note this is not 3276***7***]

The values 65535 (0xFFFF) and 32767 (0x7FFF), respectively, are used for the indication of erroneous values or measurement values that are not available. More details about the error can be evaluated from the status registers.

The assignment of values to the available register addresses (0 … 124) has been arranged in a way so that the user can read the most frequently used data with few (ideally only one) register block requests.

The following blocks have been defined:

- Status information
- Frequently used values which do not have alternative units (no units or SI only)
- Frequently used values in SI (metric) units
- Frequently used values in Imperial (US) units
- Other measurement values

When using the SI (metric) unit system, the first three blocks can supply all data usually required with one request.

For detailed information about measurement ranges, units etc. please refer to the description of the channels earlier in the manual.

Status information

Reg. Addr.	Range	Scaling, signed/unsigned, remarks
0	**Identification** Low Byte: WS-Typ (2,3,4,5,6) High Byte: Software Version	
1	**Device status**	Any value except 0 indicates an internal error; Contact NRG Technical Support
2	**Sensor status 1** Air temperature, air temperature buffer, barometric pressure, barometric pressure buffer	Coding 4 bit per status, signed, see details below.
3	**Sensor status 2** Wind, wind buffer	Coding 4 bit per status, signed, see details below.
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	
9	**Diagnostics**	Number of seconds since the last reset (divided by 10)

Frequent Measurements with No Units or SI (Metric) Only

Reg. Addr.	Range	Scaling, signed/unsigned, remarks
10	Relative Barometric Pressure, kPa (act.)	Factor 10, signed
11	Relative Barometric Pressure, kPa (min.)	Factor 10, signed
12	Relative Barometric Pressure, kPa (max.)	Factor 10, signed
13	Relative Barometric Pressure, kPa (avg.)	Factor 10, signed
14	Wind Direction (act.)	Factor 10, signed
15	Wind Direction (min.)	Factor 10, signed
16	Wind Direction (max.)	Factor 10, signed
17	Wind Direction (vct.)	Factor 10, signed
18	Wind Measurement Quality	Factor 1, signed

Frequent Measurements in SI (Metric) Units		
Reg. Addr.	**Range**	**Scaling, signed/unsigned, remarks**
19	Virtual Air Temperature, °C (act.)	Factor 10, signed
20	Virtual Air Temperature, °C (min.)	Factor 10, signed
21	Virtual Air Temperature, °C (max.)	Factor 10, signed
22	Virtual Air Temperature, °C (avg.)	Factor 10, signed
23	Heating Temperature - Top, °C	Factor 10, signed
24	Heating Temperature - Bottom, °C	Factor 10, signed
25	Wind Speed, m/s (act.)	Factor 10, signed
26	Wind Speed, m/s (min.)	Factor 10, signed
27	Wind Speed, m/s (max.)	Factor 10, signed
28	Wind Speed, m/s (avg.)	Factor 10, signed
29	Wind Speed, m/s (vct.)	Factor 10, signed

Frequent Measurements in Imperial Units		
Reg. Addr.	**Range**	**Scaling, signed/unsigned, remarks**
30	Virtual Air Temperature, °F (act.)	Factor 10, signed
31	Virtual Air Temperature, °F (min.)	Factor 10, signed
32	Virtual Air Temperature, °F (max.)	Factor 10, signed
33	Virtual Air Temperature, °F (avg.)	Factor 10, signed
34	Heating Temperature - Top, °F	Factor 10, signed
35	Heating Temperature - Bottom, °F	Factor 10, signed
36	Wind Speed, mph (act.)	Factor 10, signed
37	Wind Speed, mph (min.)	Factor 10, signed
38	Wind Speed, mph (max.)	Factor 10, signed
39	Wind Speed, mph (avg.)	Factor 10, signed
40	Wind Speed, mph (vct.)	Factor 10, signed

Additional Measurements		
Reg. Addr.	**Range**	**Scaling, signed/unsigned, remarks**

41	Absolute Barometric Pressure, kPa (act.)	Factor 10, signed
42	Absolute Barometric Pressure, kPa (min.)	Factor 10, signed
43	Absolute Barometric Pressure, kPa (max.)	Factor 10, signed
44	Abs. Barometric Pressure, kPa (avg.)	Factor 10, signed
45	Wind Speed, km/h (act.)	Factor 10, signed
46	Wind Speed, km/h (min.)	Factor 10, signed
47	Wind Speed, km/h (max.)	Factor 10, signed
48	Wind Speed, km/h (avg.)	Factor 10, signed
49	Wind Speed, km/h (vct.)	Factor 10, signed
50	Wind Speed, kts (act.)	Factor 10, signed
51	Wind Speed, kts (min.)	Factor 10, signed
52	Wind Speed, kts (max.)	Factor 10 , signed
53	Wind Speed, kts (avg.)	Factor 10, signed
54	Wind Speed, kts (vct.)	Factor 10, signed
55		
...	Reserved	
124		

Sensor Status Information Details:

Each register holds 4 sensor status codes at 4 bits per status. The sequence of status values defined in the table above are in order from most significant half byte to least significant half byte. Most of the sensors have two status values, one for the sensor itself and the current measurement value, another one for the buffer from which average, minimum, and maximum values are evaluated.

The following table shows the status coding:

Sensor State	Code
OK	0
INVALID_CHANNEL	1
Factory Use Only	2
MEAS_ERROR, MEAS_UNABLE	3
Factory Use Only	4
VALUE_OVERFLOW CHANNEL_OVERRANGE VALUE_UNDERFLOW CHANNEL_UNDERRANGE	5
BUSY	6
Factory Use Only	7

14 Appendix B: Digital Communication – NMEA

14.1 General

Wind direction and wind speed, in accordance with NMEA protocol, can be requested via the NMEA protocol. It can also be used to control heating modes, communication parameters, and measurement scaling. The RT240 and RT20 implement the NMEA-0183 version. While the NMEA standard specifies a baud rate of 4800, the RT240 and RT20 can operate at a wide range of speeds.

The device will not respond to unrecognizable NMEA commands.

Note: The use of a binary protocol (MODBUS, UMB) is recommended for lengthy transmission routes (e.g. network, GPRS/UMTS), as NMEA protocol is unable to detect transmission errors (not CRC-secured).

In the NMEA protocol, it is possible to control the telegram output by means of the control line when using full duplex operation.

14.1.1 Structure

An NMEA command is initiated by the ID and concluded with the CR sign (0Dh). Note that there is no <LF> character after commands. Sending a <LF> after the <CR> can cause data corruption since the sensor responds immediately after receiving the <CR> and may "step on" the <LF>. Characters that represent an ASCII value are in ordinary quotes.

14.1.2 Summary of NMEA commands

Command	Function
TR	Telegram request
TT	Independent telegram transmission
KY	Access mode (read only/admin)
DM	Duplex mode
HP	Heating duty
HT	Heating mode
ID	Device ID
MD	Measurement interval
OR	Output interval
OS	Scaling of wind speed
RS	Triggers software reset
TG	Control line trigger property
XX	Switches to UMB binary protocol (temporary)

Differentiation is made between 2 authorization levels when sampling:

- Read only and
- Admin

The settings for all parameters can be requested in both modes but can only be changed in "Admin" mode. In "Read only" mode it is only possible to enable automatic telegram transmission and to trigger a software reset.

14.1.3 Telegram request (NMEA)

Description: This command requests the NMEA telegram.

Request:	<ID>'TR4'(CR)
<ID>	Device address (2 decimal places with leading zeros)
Response:	$WIMWV,xxx.x,R,xxx.x,M,A*xx(CR)(LF)
$WIMWV,	fix
xxx.x	Wind direction
,R,	fix
xxx.x	Wind speed
,	fix
M	Possible values K,N,M,S for km/h, Knots, m/s, mph
,	fix
A	A=valid value, V= invalid value
*	Check sum identifier
xx	Check sum (high byte first)
CR	Carriage Return
LF	Line Feed

Response in case of error

Request:	<ID>'TR4'(CR)
<ID>	Device address (2 decimal places with leading zeros)
Response:	$WIMWV,,R,,M,V*(CR)(LF)
$WIMWV,	fix
,R,	fix
,	fix
M	Possible values K,N,M,S for km/h, Knots, m/s, mph
,	fix

V	V= invalid value
*	Check sum identifier
xx	Check sum (high byte first)
CR	Carriage Return
LF	Line Feed

Example:

Request: 01TR4

Response: $WIMWV,230.6,R,003.4,N,A*23

This means that the wind is coming at a speed of 3.4 knots from 230.6°

14.1.4 Independent telegram transmission (NMEA)

Description: This command is used to disable/enable independent transmission of the NMEA telegram. Independent transmission can be enabled in full duplex mode only.

Response: <ID>'TT'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0…disabled

4…enabled

The current setting is delivered as the response if no entry is made for <value>.

Response: $WIMWV,xxx.x,R,xxx.x,M,A*xx(CR)(LF) every 1-10 seconds (depending on OR)

$WIMWV, fix

xxx.x Wind direction

,R, fix

xxx.x Wind speed

, fix

M Possible values K,N,M,S for km/h, Knots, m/s, mph

, fix

A A=valid value, V= invalid value

* Check sum identifier

xx Check sum (high byte first)

CR Carriage Return

LF Line Feed

Response in case of error

Request: <ID>'TT'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0…disabled

4…enabled

Response: $WIMWV,,R,,M,V*(CR)(LF)

$WIMWV,	fix
,R,	fix
,	fix
M	Possible values K,N,M,S for km/h, Knots, m/s, mph
,	fix
V	V= invalid value
*	Check sum identifier
xx	Check sum (high byte first)
CR	Carriage Return
LF	Line Feed

Note: If the sensor is being operated in half-duplex mode, the following error will be reported:

Cyclic data telegrams because of half-duplex mode not allowed!

Access mode

Description: This command is used to switch between Read only and Admin modes. Controlling these modes is required when changing most sensor parameters using the NMEA protocol.

Request: <ID>'KY'<key>(CR)

<ID> Device address (2 decimal places with leading zeros)

<key> 0 Read only

4711 Admin

It is only possible to set parameters in Admin Mode only. The parameters are effective immediately after setting. However, they are only stored permanently in the sensor **after** quitting Admin Mode and returning to Read Only Mode. Parameters that were changed in error, but not yet saved by changing to Read Only Mode, can be reset by briefly disconnecting the sensor from the power supply.

Response on change from Read only mode to Admin mode:

!00KY04711

Setting rights -> ADMIN

Save new configuration with 'idKY00'

Response on change from Admin mode to Read only mode:

!00KY00000

Setting rights -> READ ONLY

Configuration saved.

14.1.5 Duplex mode

Description: This command is used to switch between half and full duplex.

Note: Switchover takes place immediately, i.e. a suitable communication module must then be connected to the sensor. If the switchover is made in error, the previous setting can be restored by briefly disconnecting the sensor from the power supply.

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'DM'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0 …half duplex

1…full duplex

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

14.1.6 Heating duty

Description: This command is used to switch between full and half (alternating) heating duty. (Although the RT20 will accept this command, it has only one heater and, therefore, does not offer half heating duty).

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'HP'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0 …full heating duty

1… alternating heating

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

Note: <value> will be padded with 4 leading zeros.

14.1.7 Heating mode

Description: This command is used to switch between 4 heating modes. The trigger property TG is automatically set to 0 (disabled) when the setting the heating mode to 3 or 4.

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'HT'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0: Heating is always off

1: Heating is automatically controlled

The heater switches on when the housing temperature falls below the heater set point and back off once the temperature reaches 5° above the setpoint. This set point is part of the factory configuration based on customer specification.

2: The switch-on temperature is shifted to +40°C; thus the heating switches on at room temperature (for test purposes only)

3: Heating is disabled when the control line is at "high" level, otherwise automatic

4: Heating is disabled when the control line is at "low" level, otherwise automatic

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

Note: <value> will be padded with 4 leading zeros.

14.1.8 Device ID

Description: This command is used to set the sensor ID. Allowable ID's range from 0 to 98

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'ID'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> New ID

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

Note: <value> will be padded with 4 leading zeros.

14.1.9 Measurement interval

Description: This command is used to set the measurement interval (update rate).

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'MD'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 1..10 seconds

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

14.1.10 Output interval

Description: This command is used to set the time interval for telegram transmission when independent telegram transmission (TT) is enabled.

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'OR'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 1..10 seconds

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

14.1.11 Scaling the wind speed

Description: This command is used to set the unit for wind speed.

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'OS'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0 …m/s

1…km/h

2…miles/h

3…knots

The current setting is delivered as the response if no entry is made for <value>.

Response: **!**<ID><value>(CR)

14.1.12 Control line trigger property

Description: This command is used to set the trigger property when independent telegram transmission (TT) is enabled. If, when enabling the function, the *heater* control mode is 3 or 4 (heater control via control line), the heating control setting automatically switches to 1 (automatic mode).

Note: The sensor must be in ADMIN mode to change this setting. See Access Mode command. You must subsequently put the sensor back into Read Only mode to permanently save this setting to the sensor.

Request: <ID>'TG'<value>(CR)

<ID> Device address (2 decimal places with leading zeros)

<value> 0: Disabled

1: Telegram transmission triggered on rising edge of control voltage

2: Telegram transmission triggered on falling edge of control voltage

3: Telegram transmission while control voltage is "high"

4: Telegram transmission while control voltage is "low"

The current setting is delivered as the response if no entry is made for <value>.

Response: !<ID><value>(CR)

14.1.13 Software reset

Description: This command is used to trigger a software reset

Request: <ID>‘RS1’(CR)

<ID> Device address (2 decimal places with leading zeros)

Response: !<ID><value>(CR)

As with startup, after a reset, the sensor will report the following:

---

ultrasonic metal wind sensor

Serial-No:1011-061

Firmware:1.6

System-ID:00

Serial-COM:2-wire

14.1.14 CRC Calculation

The CRC is calculated in accordance with the following rule:

The check sum is a running exclusive or (XOR) of all characters of the telegram, left to right, including the separators ´,´ but excluding ´$´ and ´*´. The hexadecimal value of the upper and lower 4 bits of the result are converted into two ASCII characters (0-9,A-F) for transmission. The high byte is transmitted first.

Further information on the description of a CRC calculation is available in the NMEA 0183 protocol.

15 Appendix C: Digital Communication – SDI-12

The communication in the SDI-12 mode of the RT240 and RT20 conforms to the standard defined in "*SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors Version 1.3 January 12, 2009*". The sensor may be operated in bus mode together with other SDI-12 sensors connected to one SDI master. The master can be a data logger or turbine controller as appropriate (hereafter referred to as the controller).

The implementation of the SDI-12 protocol includes all measurements of which the sensor is capable, including the translation into different unit systems [SI (metric), Imperial …). However, for compatibility to older implementations of the SDI-12 standard, the RT240 and RT20 also offer a reduced "Base" data set with the most common measurements.

15.1.1 Preconditions for SDI-12 Operation

For SDI-12 communications, the control input (pin 3 of the connector or the red wire) must be tied to analog ground (Pin 6 of the connector or the blue wire). The baud rate is 1200 and the serial interface is half duplex.

15.1.2 Command Set

For details of the SDI-12 protocol, please refer to the above mentioned standard document.

The following commands are available for the RT240 and RT20:

Command	Function
?!	Address search (Wildcard request, one device only on bus!)
a!	Request device active?
aI!	Request device identification
aAb!	Address change to b (0 … 9, A …Z, a … z)
aM!	Measurement, minimal base data set
aM1!	Measurement, Temperature Values
aM2!	Measurement: Wind Values
aM3!	Measurement: Barometric Pressure Values
aMC!	Measurement, minimal base data set, transmit values with CRC
aMC1! … aMC3!	Measurement, (value assignment as for aMn! commands), transmission with CRC
aC!	Concurrent measurement, complete base data set
aC1! … aC3!	Concurrent measurement, (value assignment as for aMn! Commands), extended data set
aCC!	Concurrent measurement, complete data set,, transmit values with CRC
aCC1! … aCC3!	Concurrent measurement, complete data set,, (value assignment as for aMn! Commands), extended data set , transmit values with CRC
aD0!	Data request buffer 0
aD1!	Data request buffer 1
aD2!	Data request buffer 2
aD3!	Data request buffer 3
aD4!	Data request buffer 4
aR0!	Data request from continuous measurement, data set 0
aR1!	Data request from continuous measurement, data set 1

aR2!	Data request from continuous measurement, data set 2
aR3!	Data request from continuous measurement, data set 3
aR4!	Data request from continuous measurement, data set 4
aRC0!	Data request from continuous measurement, data set 0 with CRC
aRC1!	Data request from continuous measurement, data set 1 with CRC
aRC2!	Data request from continuous measurement, data set 2 with CRC
aRC3!	Data request from continuous measurement, data set 3 with CRC
aRC4!	Data request from continuous measurement, data set 4 with CRC
aV!	Command verification: Evaluate sensor status and heating temperatures, data request with aD0!, aD1!
aXU<m/u>!	Selection of the unit system for SDI12 data
aXH+nnnn!	Adjust the local altitude for calculation of relative barometric pressure
aXMn!	Select the heating mode of the device (
aXR!	Device Reset

Note: Due the applied measurement processes, the RT240 and RT20 will *always* measure continuously, unlike other sensors described in the SDI-12 document. This causes some special properties:

- The device does not need a "Wakeup" and does not have a sleep mode. Therefore, the reactions to "Break" signals and any related timings do not apply.
- Data requested with M- or C- commands are always available immediately. The device will always respond with "*a000n"* or a "*a000nn"*, respectively. The sensor will not send any service request and will ignore measurement abort signals. The controller should request the data immediately. If a new measurement becomes available between the M/C command and the D command, the buffers will be updated. Once data reading begins, the buffers will be locked.
- M- and C- commands only differ in the number of values made available in the buffers (in both cases, up to the maximum permitted by the standard of 9 and 20, respectively).
- *We recommend the use of the continuous measurement commands (R-commands) to request the data*.

15.1.3 Measurement and Sensor Settings Data Messages

15.1.3.1 Units

Though the RT240 and RT20 are capable of both SI (metric) and Imperial units for SDI-12, it has been factory configured to be one or the other based on customer specification (as a simplification for SDI-12 usage). The configured system of units is not indicated in the data messages. However, the controller may request this setting with the I-command and evaluate the data messages accordingly. In addition, the selection of units can be changed through the SDI-12 interface using a special "X" command. See below.

15.1.3.1 Settings

The sensor's heating system can be controlled though the SDI-12 interface as well. Finally, the altitude of the sensor can be programmed to re-reference the pressure measurements. Both of these controls are described below.

15.1.3.1 Measurement Data Structures

The sensor has five buffers, '0' through '4'. Each buffer holds four measurement values (typically). In this way, responses to all data requests are limited to 35 characters which is an approach acceptable to all types of measurement requests. (C-requests are permitted to accept as many as 75 characters per the SDI-12 standard.)

M-requests are limited to a maximum of 9 values. Therefore, the most common measurements have been placed in Buffers '0' and '1' of the ***Base*** Data Set. Buffers '2,', '3', and '4' contain several more (though not all) of the measurements generated by the sensor. These additional values are available on request by C commands. This definition guarantees the compatibility to controllers designed according to older versions of the SDI-12 standard.

The *complete* range of measurement values produced by the sensor (though not both SI and Imperial) is available in the SDI-12 environment through the "Additional Measurements" M and C commands (aM1! … aM3!, aMC1! … aMC3!, aC1! … aC3!, aCC1! … aCC3!). See the "Additional Measurement" commands section and its buffer structures below.

If the measurement value is not available for some reason, e.g. sensor failure, this is indicated by a value of +999.0 or -999.9. The controller can then evaluate the reason for failure by an aV! verification request.

The following tables show the measurement values in the sequence they are arranged in the telegram (see example below).

15.1.3.2 Buffer Assignment <u>Base</u> Data Set

SI (Metric) units:

Measurement value	Min	Max	Unit
Buffer '0'			
Air temperature (current)	-50.0	70.0	°C
Wind Speed(current)	0.0	75.0	m/s
Wind Speed (max)	0.0	75.0	m/s
Wind Speed (average)	0.0	75.0	m/s
Buffer '1'			
Wind Direction (current)	0.0	359.9	°
Wind Direction (vector average)	0.0	359.9	°
Wind Quality	0.0	100.0	%
Rel. Barometric Pressure (current)	300	1200	hPa

Buffer '2'			
Wind Speed (min)	0.0	75.0	m/s
Wind Speed (vector average)	0.0	75.0	m/s
Wind Direction (min)	0.0	359.9	°
Wind Direction (max)	0.0	359.9	°
Buffer '3'			
Air temperature (min)	-50.0	70.0	°C
Air temperature (max)	-50.0	70.0	°C
Air temperature (average)	-50.0	70.0	°C
Buffer '4'			
Rel. Barometric Pressure (min)	300	1200	hPa
Rel. Barometric Pressure (max)	300	1200	hPa
Rel. Barometric Pressure (average)	300	1200	hPa

Imperial Units

Measurement Value	Min	Max	Unit
Buffer '0'			
Air Temperature (current)	-58.0	158.0	°F
Wind Speed(current)	0.0	167.8	Mph
Wind Speed (max)	0.0	167.8	mph
Wind Speed (average)	0.0	167.8	mph
Buffer '1'			
Wind Direction (current)	0.0	359.9	°

Wind Direction (vector average)	0.0	359.9	°
Wind Quality	0.0	100.0	%
Rel. Barometric Pressure (current)	300	1200	hPa
Buffer '2'			
Wind Speed (min)	0.0	167.8	mph
Wind Speed (vector average)	0.0	167.8	mph
Wind Direction (min)	0.0	359.9	°
Wind Direction (max)	0.0	359.9	°
Buffer '3'			
Air temperature (min)	-58.0	158.0	°F
Air temperature (max)	-58.0	158.0	°F
Air temperature (average)	-58.0	158.0	°F
Buffer '4'			
Rel. Barometric Pressure (min)	300	1200	hPa
Rel. Barometric Pressure (max)	300	1200	hPa
Rel. Barometric Pressure (average)	300	1200	hPa

15.1.3.3 Example Conversation (Base Data Set)

Note: The examples in the following sections use italics to represent the requests from the controller (e.g. *0V!*)

Example: M-Request, SI (metric) configuration

0M!

00008<CR><LF> (8 Values are available)

0D0!

0+13.5+2.5+3.7+2.6<CR><LF>

- Air temperature =13.5°C
- Current wind speed = 2.5m/s
- Max. wind speed = 3.7m/s
- Average wind speed = 2.6m/s

0D1!

0+136.4+134.0+100.0+1010<CR><LF>

- Current wind direction = 136.4°
- Wind direction(vector average) = 134.0°
- Quality of wind measurement = 100%
- Current relative barometric pressure = 1010 hPa

Example: C-Request, SI (metric) configuration

0C!

000018<CR><LF> (18 Values available)

0D0!

0+13.5+2.5+3.7+2.6<CR><LF>

- Air temperature = 13.5°C
- Current wind speed = 2.5m/s
- Maximum wind speed = 3.7m/s
- Average wind speed 2,6m/s

0D1!

0+136.4+134.0+100.0+1010<CR><LF>

- Current wind direction = 136.4°

- Wind direction(vector average) = 134.0°
- Quality of wind measurement = 100%
- Current relative barometric pressure = 1010 hPa

0D2!

0+1.8+2.8+122.0+147.0<CR><LF>

- Minimum wind speed = 1.8m/s
- Wind speed (vectpr average) = 2.8m/s
- Minimum wind direction = 122.0°
- Maximum wind direction = 147.0°

0D3!

0+12.4+14.0+13.5<CR><LF>

- Minimum air temperature = 12.4°C
- Maximum air temperature = 14.0°C
- Average air temperature = 13.5°C

0D4!

0+1008+1011+1009<CR><LF>

- Minimum relative barometric pressure = 1008 hPa
- Maximum relative barometric pressure = 1011 hPa
- Average relative barometric pressure = 1009 hPa

15.1.4 "Additional Measurement" Commands

Using the "Additional Measurement" commands, all RT240 and RT20 measurements are available in an SDI-12 environment.

aM1! … aM3!

aMC1! … aMC3!(M command, with CRC)

aC1! … aC3!

aCC1! … aCC3! (C command, with CRC)

The buffer assignment defined below typically uses the D0 and D1 buffers only. However, in the case of the Wind group, the C command will also fill the D2 buffer and transfer the Wind Quality Measurement value. Note that using the M command, the Wind Quality Measurement value is not available (only 9 values allowed for the M command).

Note also that the measurement values are grouped according to their measurement types (temperature, wind, pressure).

M1 / C1	Temperature	M: 4 Values	C: 4 Values
M2 / C2	Wind	M: 9 Values	C: 10 Values
M3 / C3	Barometric Pressure	M: 8 Values	C: 8 Values

15.1.4.1 Buffer Assignment for Additional Measurements M1 and C1 Temperature Group

Sensor configured for measurement values in SI units

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Air temperature (current)	100	-50.0	70.0	°C
Air temperature (min)	120	-50.0	70.0	°C
Air temperature (max)	140	-50.0	70.0	°C
Air temperature (avg)	160	-50.0	70.0	°C

Sensor configured for measurement values in Imperial units:

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Air temperature (current)	105	-58.0	158.0	°F
Air temperature (min)	125	-58.0	158.0	°F
Air temperature (max)	145	-58.0	158.0	°F
Air temperature (avg)	165	-58.0	158.0	°F

15.1.4.2 Buffer Assignment for Additional Measurements M2 and C2

Wind Group

Sensor configured for measurement values in SI units:

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Wind Speed (current)	400	0.0	75,0	m/s
Wind Speed (min)	420	0.0	75,0	m/s
Wind Speed (max)	440	0.0	75,0	m/s
Wind Speed (avg)	460	0.0	75,0	m/s
Wind Speed (vct)	480	0.0	75,0	m/s
Buffer '1'				
Wind Direction (current)	500	0.0	359.9	°
Wind Direction (min)	520	0.0	359.9	°
Wind Direction (max)	540	0.0	359.9	°
Wind Direction (vct)	580	0.0	359.9	°
Buffer '2'				
Wind Measurement Quality	805	0.0	100.0	%

Note that "Wind Measurement Quality" will not be available for aM2! (only 9 values allowed). It *is* available with the aC2!.

Sensor configured for measurement values in Imperial units:

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Wind Speed (current)	410	0.0	167.8	mph

Wind Speed (min)	430	0.0	167.8	mph
Wind Speed (max)	450	0.0	167.8	mph
Wind Speed (avg)	470	0.0	167.8	mph
Wind Speed (vct)	490	0.0	167.8	mph
Buffer '1'				
Wind Direction (current)	500	0.0	359.9	°
Wind Direction (min)	520	0.0	359.9	°
Wind Direction (max)	540	0.0	359.9	°
Wind Direction (vct)	580	0.0	359.9	°
Buffer '2'				
Wind Measurement Quality	805	0.0	100.0	%

15.1.4.3 Buffer Assignment for Additional Measurements M3 and C3

Barometric Pressure Group

Sensor configured for measurement values in SI *or* Imperial units:

Measurement value	UMB Channel	Min	Max	Unit
Buffer '0'				
Abs. Barometric Pressure (current)	300	300	1200	hPa
Abs. Barometric Pressure (min)	320	300	1200	hPa
Abs. Barometric Pressure (max)	340	300	1200	hPa
Abs. Barometric Pressure (avg)	360	300	1200	hPa
Buffer '1'				
Rel. Barometric Pressure (current)	305	300	1200	hPa
Rel. Barometric Pressure (min)	325	300	1200	hPa
Rel. Barometric Pressure (max)	345	300	1200	hPa
Rel. Barometric Pressure (avg)	365	300	1200	hPa

Example: Request with an Additional Measurements M command, SI units.

0M2!

00009<CR><LF>

0D0!

0+18.5+8.2+25.2+20.5+17.2<CR><LF>

- Current Wind Speed = 18.5m/s

- Minimum Wind Speed = 8.2m/s
- Maximum Wind Speed = 25.2m/s
- Average Wind Speed = 20.5m/s
- Vector Average Wind Speed = 17.2m/s

0D1!

0+180.2+178.5+182.5+180.6<CR><LF>

- Current wind direction = 180.2°
- Minimum wind direction = 178.5°
- Maximum wind direction = 182.5°
- Wind direction(vector average) = 180.6°

Example: Request with an Additional Measurements C command, SI units.

0C2!

00010<CR><LF>

0D0!

0+18.5+8.2+25.2+20.5+17.2<CR><LF>

- Current Wind Speed = 18.5m/s
- Minimum Wind Speed = 8.2m/s
- Maximum Wind Speed = 25.2m/s
- Average Wind Speed = 20.5m/s
- Vector Average Wind Speed = 17.2m/s

0D1!

0+180.2+178.5+182.5+180.6<CR><LF>

- Current wind direction = 180.2°
- Minimum wind direction = 178.5°
- Maximum wind direction = 182.5°
- Wind direction(vector average) = 180.6°

0D2!

0+95<CR><LF>

- Wind Measurement Quality = 95%

Device Identification Command

The device responds to the identification request with following message (example for SDI-12 device address '0':

0I!

013Lufft.deVentusy00

y: Metric / US units (m = (SI) metric, u = (Imperial) US)

i.e. for an RT240 or RT20, configured for Imperial units:

0I!

013Lufft.deVentusu00

15.1.5 Verification Command

The verification command aV! is used to evaluate the status information of the sensor. The sensor responds with

a0004<CR<LF>

i.e. 4 values are available in the buffers.

The first two "measurement values" transmitted in buffer '0' contain the status information of the measurement channels.

The last two values, transmitted in buffer '1', show the temperatures of the upper and the lower portions of the sensor.

The status data of the channels are arranged into two "fake" measurement values in Buffer '0', four digits for the first status group and two for the second status group, each digit representing one status value. This organization is shown in the table below, followed by the table of sensor status codes.

Note: Generally each "sensor" has two status values, one for the current measurement value, and one for the value buffer, which is used for averaging and the evaluation of minimum and maximum.

Data Organization:

Buffer '0'	
Status Group 1: **+nnnn**	Air temperature, air temperature buffer, barometric pressure, barometric pressure buffer
Status Group 2: **+nn**	Wind, wind buffer

Buffer '1', device configured for **SI (metric)** units				
Measurement value		min	max	Unit
Heating temperature - top		-50	+150	°C
Heating temperature – bottom		-50	+150	°C
Buffer '1', device configured for **Imperial** (**US)** units				
Heating temperature - top		-58	+302	°F
Heating temperature - bottom		-58	+302	°F

Since the RT20 only has a bottom heater, the second heater temperature value is undefined.

Sensor status codes:

Sensor status	Code
OK	0
UNGLTG_KANAL	1
E2_CAL_ERROR E2_CRC_KAL_ERR FLASH_CRC_ERR FLASH_WRITE_ERR FLASH_FLOAT_ERR	2
MEAS_ERROR	3
MEAS_UNABLE	4
INIT_ERROR	5
VALUE_OVERFLOW CHANNEL_OVERRANGE	6
VALUE_UNDERFLOW CHANNEL_UNDERRANGE	7
BUSY	8
other sensor status	9

Example (SDI-12 Address '0'):

0V!

00004<CR><LF>

0D0!

0+0000+00<CR><LF>

0D1!

0+73.0+65.3<CR><LF>

- No errors
- Temperature of the top = 73.0
- Temperature of the bottom = 65.3

Example (SDI-12 Address '0'):

0V!

00004<CR><LF>

0D0!

0+0300+00<CR><LF>

0D1!

0+73.0+65.3<CR><LF>

- air temperature buffer measurement error
- Temperature of the top = 73.0
- Temperature of the bottom = 65.3

15.1.6 Measurement Unit System Selection Command

The command is used to change the unit system used for the display of the SDI-12 data between SI (metric) and Imperial (US) units. The command is implemented as X (extended) command.

Command: aXU<u/m>!

Response: aU<u/m><CR><LF>

u: Imperial (US)-Units, m: SI (Metric) Units

Example: Select SI (metric) units

0XUm!

0Um<CR><LF>

15.1.7 Message Adjustment of the Altitude

For the calculation of the relative barometric pressure, the local altitude (meters above sea level) of the device is required.

Command: aXH+nnnn!

nnnn: Altitude of Sensor in m

Response: aXH+nnnn<CR><LF>

The assignment of an invalid altitude (outside the following range: -100 < altitude < 5000) will be answered with

aXHf<CR<<LF>

Example: The altitude of the location of installation is 135m

0XH+135!

0XH+135<CR><LF>

15.1.8 Set Heating Mode Command

The RT240 has 2 heating elements to keep the sensor free of snow and ice: one in the upper portion of the sensor, and one in the lower portion. The RT20 has one heater in the lower portion.

The heating of the RT240 can be operated in 3 different modes (RT20: 2 modes):

0: Heating always off

1: Automatic

The heating switches on when the housing temperature falls below the heater setpoint (adjustable between 2°C and 50°C, set by the factory per customer specification) and switches off at a housing temperature 5°C above the setpoint.

2: Automatic Alternating (RT240 only, maximum 150W heating)

The top cover plate heater alternates with the base plate heater (approximately 100W and 150W respectively).

Note: When alternating, if the set point temperature (plus 5°C) is not reached within 4 minutes, power is switched to the other heater.

Command: aXMn!

n: Heating Mode (0: Off, 1: Automatic, 2: Automatic Alternating)

Response: aXMnm<CR><LF>

n: selected heating mode: 0 = off, 1 = automatic

m: alternation: 0 = continuous, 1 = alternating

The assignment of an invalid heating mode will be answered with

aXMf<CR><LF>

Setting an RT20 to Mode 2 is invalid.

Example: An RT240 set to Automatic/Alternating

0XM2!

0XM11<CR><LF>

16 Appendix D: Warranty/Repairs

16.1 Two Year Limited Warranty

NRG Systems, Inc. (NRG) warrants its products for a period of two years from the date of original purchase solely for the benefit of the original consumer purchaser. If this NRG product is determined to be defective in materials or workmanship, NRG will, at NRG's option, repair or replace this product without charge. This warranty does not cover damage due to improper installation or use, accident or misuse, lightning or damages due to any unauthorized service. This warranty also will not apply if any seal on any instrument or sensor is broken or the equipment is not grounded.

To return a defective product, call NRG Systems at the telephone number listed below for an RMA number. You must have available when you call the serial number of the item as well as the date purchased. *No products will be accepted for warranty work without an RMA number.* The product must be returned, postage prepaid, to NRG. Include a brief description of the problem, RMA number and a return address with phone number.

The foregoing limited warranty is given in lieu of all other warranties, express or implied. NRG specifically disclaims all implied warranties, including, but not limited to, any implied warranties of merchantability and fitness for a particular purpose.

The above limited warranty expressly excludes, and NRG shall not be liable for, any incidental or consequential damages caused or related to the use of, inability to use or malfunction of this product.

Prompt disposition: NRG will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within warranty. First contact NRG or representative from whom product was purchased and ask for an RMA number.

NRG will also make a good faith effort for prompt service after the warranty period. Contact NRG with the nature of the problem and obtain an RMA number.

Inspect your shipments for damaged or missing packages immediately upon receipt. Record any such exceptions on the freight receipt of the delivery agent. If any contents are damaged or missing, report this in writing to the freight carrier and send NRG a copy of the damage report. If you insured the shipment yourself, report any damages to your insurance carrier.

TEL: 802-482-2255 FAX: 802-482-2272 EMAIL: sales@nrgsystems.com

16.2 Return Instructions (Repairs)

INTERNATIONAL CUSTOMERS

1. Contact NRG Systems to obtain an RMA number (Return Material Authorization). Write the RMA number clearly on all shipping cartons.

2. Send your item to NRG Systems "Delivery Duty Paid" to NRG Systems (see address below) using a door-to-door courier service such as UPS, FedEx, or DHL. If the repair is not urgent, please send your package by Airmail. (Courier services deliver the package directly to us, customs cleared.)

- ***NRG will not accept packages shipped Freight Collect or with Collect charges.*** *If NRG refuses the shipment, the courier service will charge your account return freight charges.*
- ***DO NOT send return items by direct or consolidated air freight service with an airline.*** *The cost for air freight may seem lower than the courier service, but air freight costs do not include customs clearance, airport handling, break bulk fees, and inland delivery to NRG Systems.*

3. Attach a Commercial Invoice to the carton. The Commercial Invoice should include the following information:

- Name and address of the shipper.
- NRG Systems' complete address and telephone number as the consignee.
- Description of the items being returned.
- Quantity of each item being returned.
- Value for customs / insurance (purchase price or replacement cost).
- Number of cartons with respective weights and dimensions.
- Please include the following statement to avoid paying US import duties: **"These items are being returned to their U.S. manufacturer. Country of manufacture and origin is USA, HTS CODE 9801.00.1012."**
-

4. Pack your repair item in a sturdy packing carton. Tag each item with a brief description of the problem.

5. Insure your shipment against damage or loss in transit. Be sure to check the appropriate box and enter a "Value for Carriage" (insurance) on your air waybill. The value is the purchase price of the equipment or what it would cost to replace the equipment if the shipment were lost. Keep a record of the tracking number. Once your item arrives, we will assess the item and notify you of the repair cost. Any repair charges and freight costs, if applicable, are payable before NRG Systems will return the repaired item to you via door-to-door courier service. NRG Systems will send you a shipment advisement when the repaired item is shipped.

International Customers:

Before sending the repair item to NRG Systems, check with your local customs authorities about provisions in your country for exporting and re-importing repair items. Some countries treat repair shipments like new shipments and charge import duties and taxes again upon re-importation. Other countries have specific steps to follow or specific forms to complete which help reduce the import duties upon re-import of the item.

US CUSTOMERS

Please see items 1, 4, and 5 above. Send your item(s) to NRG Systems "Freight Prepaid and Insured."

Shipments sent freight collect will not be accepted by NRG Systems.

NRG Systems, Inc.

Attn: RMA- _____

110 Riggs Road

Hinesburg VT 05461 USA

17 Specifications

NRG SYSTEMS® Ultrasonic Wind Sensors

Specification	5747 IceFree Ultrasonic Wind Sensor RT240	5749 Ultrasonic Wind Sensor RT20
Sensor Type	▪ ultrasonic wind speed and direction sensor	▪ ultrasonic wind speed and direction sensor
Applications	▪ wind turbine control for onshore and offshore turbines in all weather conditions including ice and snow	▪ wind turbine control for onshore turbines in all weather conditions where significant icing is not a concern ▪ wind resource assessment
Dimensions	▪ overall height: 170 mm (6.7 inches) ▪ diameter: 150 mm (5.9 inches)	▪ overall height: 170 mm (6.7 inches) ▪ diameter: 150 mm (5.9 inches)
Weight	▪ 1.63 kg (3.59 lbs)	▪ 0.83 kg (1.83 lbs)
Heater*	▪ 240W maximum, 140W option available	▪ 20W
Signal Type*	▪ digital: RS-485 half and full-duplex (NMEA, MODBUS, UMB) or SDI-12 ▪ analog: 4-20mA, 0-10V ▪ additional signals and output scaling available	▪ digital: RS-485 half and full-duplex (NMEA, MODBUS, UMB) or SDI-12 ▪ analog: 4-20mA, 0-10V ▪ additional signals and output scaling available
Wind Direction		
Measuring Range	▪ 0° to 359.9°	▪ 0° to 359.9°
Resolution	▪ 0.1°	▪ 0.1°
Accuracy	▪ < 2° RMSE for wind speeds greater than 1.0 m/s (2.2 mph)	▪ < 3° RMSE for wind speeds greater than 1.0 m/s (2.2 mph)
Threshold*	▪ 0.1 m/s (0.22 mph)	▪ 0.3 m/s (0.67 mph)
Measurement Output Rate*	▪ 1 - 10 seconds adjustable	▪ 1 - 10 seconds adjustable
Wind Speed		
Measuring Range	▪ 0 m/s to 75 m/s (0 mph to 167.8 mph)	▪ 0 m/s to 75 m/s (0 mph to 167.8 mph)
Resolution	▪ 0.1 m/s (0.22 mph)	▪ 0.1 m/s (0.22 mph)
Accuracy	▪ ±0.2 m/s (±0.45 mph) or ±2% of reading RMS, whichever is greater	▪ ±0.3 m/s (0.67 mph) or ±3% of reading RMS for wind speeds from 0 to 35 m/s (0 to 78.3 mph), whichever is greater; ±5% RMS for wind speeds greater than 35 m/s (78.3 mph)
Threshold*	▪ 0.1 m/s (0.22 mph)	▪ 0.3 m/s (0.67 mph)
Measurement Output Rate*	▪ 1 - 10 seconds adjustable	▪ 1 - 10 seconds adjustable
Virtual Temperature		
Resolution	▪ 0.1°C (0.2°F)	▪ 0.1°C (0.2°F)
Accuracy	▪ ±2°C (±3.6°F) – can be affected by heat and sunlight	▪ ±2°C (±3.6°F) – can be affected by heat and sunlight
Measurement Output Rate*	▪ 1 - 10 seconds adjustable	▪ 1 - 10 seconds adjustable
Barometric Pressure		
Measuring Range	▪ 300 hPa to 1200 hPa (8.9 inHg to 35.4 inHg)	▪ 300 hPa to 1200 hPa (8.9 inHg to 35.4 inHg)
Accuracy	▪ ±1.5 hPa (0.04 inHg)	▪ ±1.5 hPa (0.04 inHg)
Bus Operation	▪ up to 32 devices	▪ up to 32 devices
Power Requirements		
Without Heating	▪ 12 to 24VDC±10%; 50mA (1.2W)	▪ 12 to 24VDC±10%; 50mA (1.2W)
With Heating*	▪ 24VDC±10%; 10A maximum (240W maximum, 140W+100W)	▪ 24VDC±10%; 880mA maximum (21W)
Connection	▪ 8 pole plug, Amphenol C091 31D008 101 2	▪ 8 pole plug, Amphenol C091 31D008 101 2
Housing Material	▪ aluminum	▪ polycarbonate
Pole Diameter	▪ 49.7 mm to 50.7 mm (1.957 inches to 1.966 inches)	▪ 49.7 mm to 50.7 mm (1.957 inches to 1.966 inches)
Environmental		
Operating Temperature	▪ -40°C to 60°C (-40°F to 140°F)	▪ -40°C to 60°C (-40°F to 140°F)
Protection	▪ IP65	▪ IP64

* factory configured per customer specification

To Place Your Order
Contact NRG Sales, 802-482-2255 or visit nrgsystems.com
110 Riggs Rd., Hinesburg, VT 05461 USA | info@nrgsystems.com

NRG SYSTEMS®

18 Documents of Conformity

Global leader in wind measurement

Declaration of Conformity

(in accordance with ISO/IEC 17050-1:2004)

NRG Systems Document Number: 6019, Rev A

Supplier: **NRG Systems**

Supplier Address: 110 Riggs Road, Hinesburg, VT 05461, USA
Telephone: 802 482 2255, Fax: 802 482 2272
Email: sales@nrgsystems.com

Declares that the Product: IceFree Ultrasonic Wind Sensors

Including Model Numbers:

NRG IceFree Ultrasonic Wind Sensor	Model RT-240
NRG IceFree Ultrasonic Wind Sensor Cable	Item 5843

are in conformity with the requirements of the following standards:

Safety: **IEC 61010-1 Ed. 2.0 b:2001**, "Safety requirements for electrical equipment for measurement, control, and laboratory use"

EMC: **2004/108/EC** "Council Directive of 15 December 2004, on the approximation of the Laws of Member States relating to electromagnetic compatibility"
EN61326-1:2006 Class B "Electrical Equipment for Measurement, Control, and Laboratory Use—EMC Requirements"

Additional Information:

All circuits are extra low voltage (ELV), therefore standard 2006/95/EC (the low-voltage directive) does not apply, and
This product complies with the requirements of 2004/108/EC, and therefore
The product is CE marked in accordance with 93/68/EEC.

Compliance to US FCC Part 15, Subpart A, Class B is claimed based on compliant CISPR 22 Class B results.

The test documentation is on file with Mr. R. Paul Smith, Mechanical Engineer.

Issued at Hinesburg, VT, USA
04 December 2012

Owen Clay
Engineering Manager

Tel 802.482.2255 | Fax 802.482.2272 | info@nrgsystems.com | 110 Riggs Road, Hinesburg, Vermont 05461 USA | www.nrgsystems.com

Global leader in wind measurement

Declaration of Conformity

(in accordance with ISO/IEC 17050-1:2004)

NRG Systems Document Number: 6020, Rev A

Supplier: **NRG Systems**

Supplier Address: 110 Riggs Road, Hinesburg, VT 05461, USA
Telephone: 802 482 2255, Fax: 802 482 2272
Email: sales@nrgsystems.com

Declares that the Product: IceFree Ultrasonic Wind Sensors

Including Model Numbers:

IceFree Ultrasonic Wind Sensor	Model RT-20
IceFree Ultrasonic Wind Sensor Cable	Item 5843

are in conformity with the requirements of the following standards:

Safety: **IEC 61010-1 Ed. 2.0 b:2001**, "Safety requirements for electrical equipment for measurement, control, and laboratory use"

EMC: **2004/108/EC** "Council Directive of 15 December 2004, on the approximation of the Laws of Member States relating to electromagnetic compatibility"
EN61326-1:2006 Class B "Electrical Equipment for Measurement, Control, and Laboratory Use—EMC Requirements"

Additional Information:

All circuits are extra low voltage (ELV), therefore standard 2006/95/EC (the low-voltage directive) does not apply, and
This product complies with the requirements of 2004/108/EC, and therefore
The product is CE marked in accordance with 93/68/EEC.

Compliance to US FCC Part 15, Subpart A, Class B is claimed based on compliant CISPR 22 Class B results.

The test documentation is on file with Mr. R. Paul Smith, Mechanical Engineer.

Issued at Hinesburg, VT, USA
04 January 2012

Owen Clay
Engineering Manager

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